

SECTION 11 - SENSITIVITY ANALYSIS

OVERVIEW

Given the nature and complexity of the benefit measurement procedures, an unavoidable component of uncertainty is implicit in the estimates of project benefits. A single change to any number of parameter values or assumptions holds the potential for significantly affecting benefit estimates, and ultimately, in turn, project formulation. The role of sensitivity analysis is to identify those parameters and assumptions with the greatest potential for project formulation impact and to evaluate the magnitude of those impacts for discrete changes in the key parameters. The parameters identified as potentially significant, and consequently incorporated into the sensitivity analysis, include, shallow-draft traffic projections, deep-draft traffic projections, the assumed timing of project implementation, the discount rate, and alternative design elevations for lock floor/sill construction. In the following paragraphs of this section, the impacts on project benefits and plan formulation resulting from alternative parameter values and assumptions are presented.

ALTERNATIVE TRAFFIC GROWTH

SHALLOW-DRAFT

Low Growth Scenario

Projected shallow-draft traffic volumes and commodity group growth rates reflecting the low growth scenario have been described earlier in Section 2. The result of incorporating those projected traffic volumes into the system modelling on IHNC Lock accommodated traffic, average delay, percent of total demand accommodated, unaccommodated traffic, and system benefits are detailed in tables 11 - 1 through 11 - 5, respectively.

Because of the lower overall system demand, traffic processed at IHNC Lock is consistently lower for the low growth scenario compared to the mid growth scenario. This difference is most pronounced for the lock construction scenarios where virtually all demand, for both the mid and the low scenarios, is accommodated throughout the project life. As a result, the difference between the mid and low scenarios reflects the difference in the overall level of projected traffic. However, for the without-project condition, and to a lesser extent for the bridge improvement plans, the accommodated traffic with the low

Table 11 - 2
Low Growth Scenario
IHNC Lock Average Delays
By Alternative and Year
(Hours)

Condition	1990	2000	2010	2020	2030	2040	2060
Without Project	10.4	10.0	20.8	28.2	40.7	40.7	60.2
Removal of Bridge Curfews	6.3	6.0	12.3	24.0	39.2	40.7	60.2
Replace St. Claude Bridge	3.7	3.6	6.7	15.3	27.5	40.7	54.5
900 x 90 x 22 ft. (With bridge curfews)	0.6	0.6	0.8	0.5	1.3	1.8	13.2
900 x 90 x 22 ft. (Without bridge curfews)	0.4	0.4	0.4	0.5	0.7	1.0	4.5
900 x 110 x 22 ft. (With bridge curfews)	0.3	0.3	0.4	0.5	0.6	0.7	1.5
900 x 110 x 22 ft. (Without bridge curfews)	0.3	0.3	0.4	0.4	0.5	0.7	1.3
900 x 110 x 36 ft. (With bridge curfews)	0.5	0.4	0.5	0.6	0.8	1.0	2.0
900 x 110 x 36 ft. (Without bridge curfews)	0.3	0.3	0.4	0.4	0.5	0.6	1.3
1200 x 90 x 22 ft. (With bridge curfews)	0.3	0.3	0.3	0.3	0.4	0.5	1.0
1200 x 90 x 22 ft. (Without bridge curfews)	0.2	0.2	0.3	0.3	0.4	0.5	0.9
1200 x 110 x 22 ft. (With bridge curfews)	0.2	0.2	0.2	0.3	0.3	0.4	0.6
1200 x 110 x 22 ft. (Without bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.3	0.5
1200 x 110 x 36 ft. (With bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.4	0.6
1200 x 110 x 36 ft. (Without bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.3	0.6

Table 11 - 2
Low Growth Scenario
IHNC Lock Average Delays
By Alternative and Year
(Hours)

Condition	1990	2000	2010	2020	2030	2040	2060
Without Project	10.4	10.0	20.8	28.2	40.7	40.7	60.2
Removal of Bridge Curfews	6.3	6.0	12.3	24.0	39.2	40.7	60.2
Replace St. Claude Bridge	3.7	3.6	6.7	15.3	27.5	40.7	54.5
900 x 90 x 22 ft. (With bridge curfews)	0.6	0.6	0.8	0.5	1.3	1.8	13.2
900 x 90 x 22 ft. (Without bridge curfews)	0.4	0.4	0.4	0.5	0.7	1.0	4.5
900 x 110 x 22 ft. (With bridge curfews)	0.3	0.3	0.4	0.5	0.6	0.7	1.5
900 x 110 x 22 ft. (Without bridge curfews)	0.3	0.3	0.4	0.4	0.5	0.7	1.3
900 x 110 x 36 ft. (With bridge curfews)	0.5	0.4	0.5	0.6	0.8	1.0	2.0
900 x 110 x 36 ft. (Without bridge curfews)	0.3	0.3	0.4	0.4	0.5	0.6	1.3
1200 x 90 x 22 ft. (With bridge curfews)	0.3	0.3	0.3	0.3	0.4	0.5	1.0
1200 x 90 x 22 ft. (Without bridge curfews)	0.2	0.2	0.3	0.3	0.4	0.5	0.9
1200 x 110 x 22 ft. (With bridge curfews)	0.2	0.2	0.2	0.3	0.3	0.4	0.6
1200 x 110 x 22 ft. (Without bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.3	0.5
1200 x 110 x 36 ft. (With bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.4	0.6
1200 x 110 x 36 ft. (Without bridge curfews)	0.2	0.2	0.2	0.2	0.3	0.3	0.6

Table 11 - 3
 Low Growth Scenario
 IHNC Lock Percent of Total Demand Accomodated

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	100	100	98.3	92.8	86.2	77.5	62.2
Removal of Bridge Curfews	100	100	100	97.6	90.8	81.8	65.4
Replace St. Claude Bridge	100	100	100	100	93.5	85.1	67.7
900 x 90 x 22 ft. (With bridge curfews)	100	100	100	100	100	100	100
900 x 90 x 22 ft. (Without bridge curfews)	100	100	100	100	100	100	100
900 x 110 x 22 ft. (With bridge curfews)	100	100	100	100	100	100	100
900 x 110 x 22 ft. (Without bridge curfews)	100	100	100	100	100	100	100
900 x 110 x 36 ft. (With bridge curfews)	100	100	100	100	100	100	100
900 x 110 x 36 ft. (Without bridge curfews)	100	100	100	100	100	100	100
1200 x 90 x 22 ft. (With bridge curfews)	100	100	100	100	100	100	100
1200 x 90 x 22 ft. (Without bridge curfews)	100	100	100	100	100	100	100
1200 x 110 x 22 ft. (With bridge curfews)	100	100	100	100	100	100	100
1200 x 110 x 22 ft. (Without bridge curfews)	100	100	100	100	100	100	100
1200 x 110 x 36 ft. (With bridge curfews)	100	100	100	100	100	100	100
1200 x 110 x 36 ft. (Without bridge curfews)	100	100	100	100	100	100	100

Table 11 - 4
Low Growth Scenario
IHNC Lock Traffic Unaccommodated
(1,000 tons)

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	0	0	445	1,984	4,219	7,647	16,234
Removal of Bridge Curfews	0	0	0	670	2,799	6,186	14,853
Replace St. Claude Bridge	0	0	0	12	1,986	5,068	13,884
900 x 90 x 22 ft. (With bridge curfews)	0	0	0	0	0	0	70
900 x 90 x 22 ft. (Without bridge curfews)	0	0	0	0	0	0	64
900 x 110 x 22 ft. (With bridge curfews)	0	0	0	0	0	0	58
900 x 110 x 22 ft. (Without bridge curfews)	0	0	0	0	0	0	58
900 x 110 x 36 ft. (With bridge curfews)	0	0	0	0	0	0	58
900 x 110 x 36 ft. (Without bridge curfews)	0	0	0	0	0	0	58
1200 x 90 x 22 ft. (With bridge curfews)	0	0	0	0	0	0	58
1200 x 90 x 22 ft. (Without bridge curfews)	0	0	0	0	0	0	58
1200 x 110 x 22 ft. (With bridge curfews)	0	0	0	0	0	0	58
1200 x 110 x 22 ft. (Without bridge curfews)	0	0	0	0	0	0	58
1200 x 110 x 36 ft. (With bridge curfews)	0	0	0	0	0	0	58
1200 x 110 x 36 ft. (Without bridge curfews)	0	0	0	0	0	0	58

Table 11 - 5
Low Growth Scenario
Shallow Draft
Total & Incremental Transportation Savings
(1992, \$1,000)

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	1,251,510	1,204,232	1,270,643	1,269,453	1,288,546	1,337,355	1,128,953
Removal of Bridge Curfews	1,256,850 5,339	1,209,293 5,060	1,282,732 12,089	1,275,775 6,321	1,290,956 2,410	1,337,355 c	1,128,953 0
Replace of St. Claude Bridge	1,250,154 8,644	1,212,468 8,236	1,290,921 20,277	1,289,186 19,733	1,309,501 20,955	1,337,355 c	1,138,144 9,192
900 x 90 x 22 ft. (With bridge curfews)	1,254,184 12,674	1,216,371 12,139	1,299,459 28,815	1,312,506 43,052	1,354,392 65,946	1,409,445 72,086	1,216,871 87,918
900 x 90 x 22 ft. (Without bridge curfews)	1,254,544 13,034	1,216,726 12,494	1,299,969 29,325	1,312,417 42,964	1,355,401 66,855	1,411,144 73,789	1,237,450 108,497
900 x 110 x 22 ft. (With bridge curfews)	1,254,558 13,048	1,216,738 12,506	1,300,011 29,367	1,312,502 43,049	1,355,587 67,041	1,411,600 74,242	1,244,580 115,627
900 x 110 x 22 ft. (Without bridge curfews)	1,254,596 13,085	1,216,775 12,543	1,300,064 29,421	1,312,573 43,120	1,355,689 67,143	1,411,761 74,406	1,245,187 116,234
900 x 110 x 36 ft. (With bridge curfews)	1,254,418 12,908	1,216,600 12,368	1,299,823 29,180	1,312,265 42,811	1,355,269 66,723	1,411,146 73,792	1,243,403 114,450
900 x 110 x 36 ft. (Without bridge curfews)	1,254,610 13,100	1,216,789 12,557	1,300,083 29,439	1,312,596 43,143	1,355,720 67,173	1,411,802 74,447	1,245,276 115,323
1200 x 90 x 22 ft. (With bridge curfews)	1,254,909 13,399	1,216,857 12,625	1,300,175 29,532	1,312,715 43,262	1,355,882 67,336	1,412,040 74,685	1,245,963 117,010
1200 x 90 x 22 ft. (Without bridge curfews)	1,254,920 13,410	1,216,868 12,636	1,300,192 29,549	1,312,738 43,284	1,355,916 67,370	1,412,096 74,740	1,246,175 117,222
1200 x 110 x 22 ft. (With bridge curfews)	1,254,976 13,466	1,217,152 12,920	1,300,526 29,883	1,313,118 43,664	1,356,366 67,820	1,412,655 75,296	1,247,267 118,314
1200 x 110 x 22 ft. (Without bridge curfews)	1,254,998 13,488	1,217,174 12,942	1,300,555 29,912	1,313,155 43,702	1,356,416 67,870	1,412,724 75,369	1,247,430 118,478
1200 x 110 x 36 ft. (With bridge curfews)	1,254,994 13,484	1,217,170 12,938	1,300,549 29,905	1,313,146 43,692	1,356,401 67,855	1,412,700 75,345	1,247,347 118,395
1200 x 110 x 36 ft. (Without bridge curfews)	1,254,995 13,484	1,217,170 12,938	1,300,550 29,907	1,313,149 43,695	1,356,407 67,861	1,412,711 75,356	1,247,397 118,444

scenario is significantly lower than the mid scenario only during the early years of analysis. After a point, even the lower traffic demand of the low growth scenario reaches the level where demand is high relative to capacity and traffic is diverted. In other words, the low growth scenario is able to use up the available capacity, it just takes longer than the mid growth scenario. This overall condition is mirrored in the pattern of average delay. It shows that the low growth average delay for the without-project condition is significantly lower than the mid growth average delay during the early years, but approaches, and finally reaches, the mid growth average delay in the later years.

Table 11 - 5 displays the shallow draft system benefits for the low growth scenario. It reveals that for the lock construction alternatives, low growth average annual savings are approximately 60 percent of mid growth average annual savings. The lower level of traffic demand associated with the low growth scenario generates fewer tons that can benefit from the lower delays that result from additional lock capacity.

However, for the bridge replacement plan, low growth scenario average annual savings are substantially higher vis a vis the mid growth scenario. In fact, the low growth average annual savings actually slightly exceed the mid growth annual savings. During the early project years, mid growth savings exceed those of the low growth scenario as more traffic is accommodated due to a higher demand. However, after the additional capacity that is provided by the bridge replacement plan is utilized by the increased demand, system savings are eroded to the point where the savings attributable to the additional traffic is completely offset by the increase in delay at IHNC and other system locks. With the low growth scenario, the slower rate of traffic increase means that the additional capacity is not utilized as quickly and savings are generated for a longer time, albeit, at a lower absolute level than with the mid growth. On an average annual basis, the more steady stream of low growth scenario savings is greater than the faster rising then declining savings stream of the mid growth scenario.

High Growth Scenario

Projected shallow-draft traffic volumes and commodity group growth rates reflecting the high growth scenario have also been described earlier in Section 2. The result of incorporating these projected traffic volumes into the system modelling on IHNC Lock accommodated traffic, average delay, percent of total demand accommodated, unaccommodated

traffic, and system benefits are detailed in tables 11 - 6 through 11 - 10, respectively.

Because of the greater overall system demand, traffic processed at IHNC Lock is consistently higher for the high growth scenario compared to the mid growth scenario. Unlike the mid growth scenario where the lock construction plans are able to process virtually all IHNC Lock demand, the high growth scenario generates some minimal diversions early in the project life and significant amounts late in the project life. For the bridge improvement plans, this pattern is magnified, with diversions occurring sooner and in larger quantities vis a vis the mid growth scenario. The modest capacity increases provided by the bridge improvement plans are rapidly consumed by the high growth scenario traffic demand, using up the available capacity more quickly than the mid growth scenario. This overall condition is mirrored in the pattern of average delay. It shows that the high growth average delay for the without-project condition is significantly larger than the mid growth average delay during the early years, but this difference diminishes over time. For the lock improvement plans there are only minor differences in average delay until later in the period of analysis. In the early years the percent of utilized capacity remains sufficiently low even with the high growth scenario to generate substantially different delays among alternatives. Much later in the period of analysis, when traffic demand is higher and capacity begins to be pushed for the smaller lock improvement plans, differences in average delay appear. For the bridge improvement plans, the increases in average delay occur early in the period of analysis and quickly approach the delays of the without project condition.

No Growth After 20 Years

The "No Growth After 20 Years" scenario describes a condition where traffic is projected using the mid growth rates for only twenty years beyond the baseline traffic year. Given the 1990 baseline year, the terminal year of projections, with this scenario, is 2010. Beyond 2010 traffic is held constant at the 2010 level. Because this scenario represents a truncated mid growth projection, traffic accommodated, average delays, unaccommodated traffic, and system savings are identical to the mid growth results for a specific year. However, the average annual savings for each project alternative differ from the mid growth scenario because traffic growth beyond 2010 is not considered. Average annual savings for the "No Growth After 20 Years" scenario are displayed in table 11 11.

Table 11 - 6
High Growth Scenario
IHNC Lock Traffic Accomodated
(1,000 Tons)

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	23,056	26,277	26,600	26,600	26,691	26,706	27,149
Removal of Bridge Curfews	23,056	27,252	27,738	27,999	28,072	28,072	28,416
Replace St. Claude Bridge	23,056	28,016	28,856	29,041	29,041	29,092	29,302
900 x 90 x 22 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,215	44,160	44,313
900 x 90 x 22 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	45,868	45,996
900 x 110 x 22 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,696	56,295
900 x 110 x 22 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	58,680
900 x 110 x 36 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,696	56,077
900 x 110 x 36 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	58,510
1200 x 90 x 22 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	60,677
1200 x 90 x 22 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	62,836
1200 x 110 x 22 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	69,076
1200 x 110 x 22 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	69,091
1200 x 110 x 36 ft. (With bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	69,076
1200 x 110 x 36 ft. (Without bridge curfews)	23,056	28,392	32,992	38,200	43,315	50,699	69,076

Table 11 - 7
High Growth Scenario
IHNC Lock Average Delays
By Alternative and Year
(Hours)

Condition	1990	2000	2010	2020	2030	2040	2060
Without Project	10.4	40.7	54.5	54.5	60.2	61.2	123.3
Removal of Bridge Curfews	6.3	27.5	40.7	54.5	60.2	60.2	115.4
Replace St. Claude Bridge	3.7	18.6	40.7	54.5	54.5	60.2	103.3
900 x 90 x 22 ft. (With bridge curfews)	0.6	1.0	1.7	3.5	16.4	40.7	54.5
900 x 90 x 22 ft. (Without bridge curfews)	0.4	0.6	0.9	1.7	5.2	38.2	54.5
900 x 110 x 22 ft. (With bridge curfews)	0.3	0.5	0.7	1.0	1.6	4.1	40.7
900 x 110 x 22 ft. (Without bridge curfews)	0.3	0.5	0.6	0.9	1.3	2.9	40.7
900 x 110 x 36 ft. (With bridge curfews)	0.5	0.7	0.9	1.4	2.1	5.4	40.7
900 x 110 x 36 ft. (Without bridge curfews)	0.3	0.4	0.6	0.9	1.3	2.9	40.7
1200 x 90 x 22 ft. (With bridge curfews)	0.3	0.4	0.5	0.7	1.0	2.0	40.9
1200 x 90 x 22 ft. (Without bridge curfews)	0.2	0.3	0.5	0.6	0.9	1.7	35.4
1200 x 110 x 22 ft. (With bridge curfews)	0.2	0.3	0.4	0.5	0.6	1.0	6.9
1200 x 110 x 22 ft. (Without bridge curfews)	0.2	0.3	0.3	0.4	0.6	0.9	4.4
1200 x 110 x 36 ft. (With bridge curfews)	0.2	0.3	0.3	0.4	0.6	0.9	8.6
1200 x 110 x 36 ft. (Without bridge curfews)	0.2	0.3	0.3	0.4	0.6	0.9	5.0

Table 11 - 8
High Growth Scenario
IHNC Lock Percent of Total Demand Accomodated

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	100	92.6	80.6	69.5	59.5	50.3	35.0
Removal of Bridge Curfews	100	96.0	84.1	73.2	62.6	52.9	36.6
Replace St. Claude Bridge	100	98.7	87.5	75.9	64.8	54.8	37.8
900 x 90 x 22 ft. (With bridge curfews)	100	100	100	99.8	96.4	83.2	57.1
900 x 90 x 22 ft. (Without bridge curfews)	100	100	100	99.8	96.6	86.4	59.3
900 x 110 x 22 ft. (With bridge curfews)	100	100	100	99.8	96.6	95.5	72.6
900 x 110 x 22 ft. (Without bridge curfews)	100	100	100	99.8	96.6	95.5	75.6
900 x 110 x 36 ft. (With bridge curfews)	100	100	100	99.8	96.6	95.5	72.3
900 x 110 x 36 ft. (Without bridge curfews)	100	100	100	99.8	96.6	95.5	75.4
1200 x 90 x 22 ft. (With bridge curfews)	100	100	100	99.8	96.6	95.5	78.2
1200 x 90 x 22 ft. (Without bridge curfews)	100	100	100	99.8	96.6	95.5	81.0
1200 x 110 x 22 ft. (With bridge curfews)	100	100	100	99.8	96.6	95.5	89.0
1200 x 110 x 22 ft. (Without bridge curfews)	100	100	100	99.8	96.6	95.5	89.1
1200 x 110 x 36 ft. (With bridge curfews)	100	100	100	99.8	96.6	95.5	89.0
1200 x 110 x 36 ft. (Without bridge curfews)	100	100	100	99.8	96.6	95.5	89.0

Table 11 - 9
High Growth Scenario
IHNC Lock Traffic Unaccommodated
(1,000 tons)

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	0	2,115	6,392	11,665	18,135	26,383	50,425
Removal of Bridge Curfews	0	1,140	5,254	10,266	16,754	25,017	49,158
Replace St. Claude Bridge	0	376	4,136	9,224	15,785	23,997	48,272
900 x 90 x 22 ft. (With bridge curfews)	0	0	0	65	1,611	8,939	33,261
900 x 90 x 22 ft. (Without bridge curfews)	0	0	0	65	1,511	7,221	31,578
900 x 110 x 22 ft. (With bridge curfews)	0	0	0	65	1,511	2,393	21,279
900 x 110 x 22 ft. (Without bridge curfews)	0	0	0	65	1,511	2,390	18,894
900 x 110 x 36 ft. (With bridge curfews)	0	0	0	65	1,511	2,393	21,497
900 x 110 x 36 ft. (Without bridge curfews)	0	0	0	65	1,511	2,390	19,064
1200 x 90 x 22 ft. (With bridge curfews)	0	0	0	65	1,511	2,390	16,897
1200 x 90 x 22 ft. (Without bridge curfews)	0	0	0	65	1,511	2,390	14,738
1200 x 110 x 22 ft. (With bridge curfews)	0	0	0	65	1,511	2,390	8,498
1200 x 110 x 22 ft. (Without bridge curfews)	0	0	0	65	1,511	2,390	8,483
1200 x 110 x 36 ft. (With bridge curfews)	0	0	0	65	1,511	2,390	8,498
1200 x 110 x 36 ft. (Without bridge curfews)	0	0	0	65	1,511	2,390	8,498

Table 11 - 10
High Growth Scenario
Shallow Draft
Total & Incremental Transportation Savings
(1992, \$1,000)

Alternative	1990	2000	2010	2020	2030	2040	2060
Without Project	1,251,510	1,345,946	1,318,124	1,278,015	1,158,490	1,294,706	1,154,217
Removal of Bridge Curfews	1,256,850 5,339	1,365,707 19,761	1,338,314 2,190	1,278,015 c	1,158,490 0	1,296,323 1,617	1,162,319 8,102
Replace of St. Claude Bridge	1,260,154 8,644	1,379,611 33,665	1,338,314 2,190	1,278,015 c	1,165,753 7,263	1,296,323 1,617	1,177,515 23,299
900 x 90 x 22 ft. (With bridge curfews)	1,264,184 12,674	1,407,694 61,748	1,408,846 9,722	1,327,869 49,855	1,248,771 90,281	1,333,789 39,083	1,272,469 118,253
900 x 90 x 22 ft. (Without bridge curfews)	1,264,544 13,034	1,408,441 62,495	1,411,312 93,188	1,331,745 53,730	1,276,165 117,675	1,340,368 45,662	1,272,469 118,253
900 x 110 x 22 ft. (With bridge curfews)	1,264,558 13,048	1,408,544 62,598	1,411,670 93,546	1,333,189 55,174	1,285,054 126,565	1,386,432 91,727	1,311,513 157,296
900 x 110 x 22 ft. (Without bridge curfews)	1,264,596 13,085	1,408,621 62,675	1,411,812 93,688	1,333,484 55,469	1,285,714 127,224	1,389,872 95,166	1,311,513 157,296
900 x 110 x 36 ft. (With bridge curfews)	1,264,418 12,908	1,408,290 62,344	1,411,259 93,135	1,332,479 54,464	1,283,807 125,317	1,382,707 88,002	1,311,513 157,296
900 x 110 x 36 ft. (Without bridge curfews)	1,264,610 13,100	1,408,646 62,700	1,411,850 93,726	1,333,545 55,530	1,285,806 127,317	1,390,019 95,313	1,311,513 157,296
1200 x 90 x 22 ft. (With bridge curfews)	1,264,909 13,399	1,409,057 63,111	1,412,948 12,805,824	1,334,317 56,302	1,286,972 128,482	1,392,998 98,292	1,311,487 157,271
1200 x 90 x 22 ft. (Without bridge curfews)	1,264,920 13,410	1,409,082 63,136	1,412,443 94,320	1,334,421 56,406	1,287,202 128,712	1,393,921 99,215	1,331,077 176,860
1200 x 110 x 22 ft. (With bridge curfews)	1,264,976 13,466	1,409,194 63,248	1,412,640 94,516	1,334,794 56,779	1,287,908 129,418	1,395,980 101,274	1,440,519 286,303
1200 x 110 x 22 ft. (Without bridge curfews)	1,264,998 13,488	1,409,234 63,287	1,412,033 12,803,909	1,334,899 56,884	1,288,080 129,590	1,396,347 101,641	1,450,402 296,185
1200 x 110 x 36 ft. (With bridge curfews)	1,264,994 13,484	1,409,223 63,277	1,412,682 94,558	1,334,855 56,840	1,287,991 129,501	1,396,095 101,389	1,433,734 279,517
1200 x 110 x 36 ft. (Without bridge curfews)	1,264,995 13,484	1,409,227 63,281	1,412,692 94,568	1,334,879 56,864	1,288,044 129,555	1,396,265 101,560	1,448,058 293,841

Table 11 -11
Comparison of Average Annual Shallow Draft Savings
by Traffic Growth Scenario
(1996 \$1,000, 7.375 Percent)

Alternative	Average Annual Savings					Percent Advantage VS				
	Mid	Low	High	No Growth After 20 Yrs	South American Coal	Mid Growth				South American Coal
						Mid	Low	High	No Growth After 20 Yrs	
Removal of Bridge Curfews	9,497	6,967	14,444	8,055	-	0	-27	52	-15	-
Replace of St Claude Bridge	15,378	18,016	13,164	21,615	-	0	17	-14	41	-
900 x 90 x 22 (With Bridge Curfews)	76,815	48,381	73,265	66,477	73,297	0	-37	-5	-14	-5
900 x 90 x 22 (Without Bridge Curfews)	79,885	49,591	80,896	67,345	-	0	-38	1	-16	-
900 x 110 x 22 (With Bridge Curfews)	83,885	49,964	89,625	67,532	78,319	0	-40	7	-20	-7
900 x 110 x 22 (Without Bridge Curfews)	84,569	50,065	90,283	67,619	-	0	-41	7	-20	-
900 x 110 x 36 (With Bridge Curfews)	84,508	51,312	88,222	67,219	-	0	-39	4	-20	-
900 x 110 x 36 (Without Bridge Curfews)	86,033	51,754	90,072	67,617	-	0	-40	5	-21	-
1200 x 90 x 22 (With Bridge Curfews)	86,880	51,914	91,110	68,108	-	0	-40	5	-22	-
1200 x 90 x 22 (Without Bridge Curfews)	87,028	51,949	92,082	68,138	-	0	-40	6	-22	-
1200 x 110 x 22 (With Bridge Curfews)	87,396	52,389	96,923	68,276	-	0	-40	11	-22	-
1200 x 110 x 22 (Without Bridge Curfews)	87,493	52,436	97,444	68,323	-	0	-40	11	-22	-
1200 x 110 x 36 (With Bridge Curfews)	87,448	52,421	96,725	68,339	-	0	-40	11	-22	-
1200 x 110 x 36 (Without Bridge Curfews)	87,474	52,427	96,931	68,315	-	0	-40	11	-22	-

South American Coal Imports Scenario

This scenario reflects the recent partial shift of one utility to low sulphur South American coal imports as a response to the Clean Air Act requirements. This switch, which was initiated in mid 1993, is expected to remain in effect as an extended trial for the next several years. In order to address the sensitivity of this switch as a potential long term outcome, the total coal volume shipped through IHNC Lock to this utility was assumed to be eliminated for the entire period of analysis. This traffic amounted to approximately 1.1 million tons in the 1990 baseline traffic. With this traffic eliminated, all other traffic was projected using the mid growth scenario rates.

Using the modified traffic volumes described above, system savings were calculated over the period of analysis for two lock construction alternatives, 900 x 110 x 22 ft lock with curfews, and 900 x 90 x 22 ft lock with curfews. These two sizes were selected because they represent the NED Plan and the next smallest increment, respectively. For all of the lock construction plans, reductions in traffic of this magnitude will consistently result in lower average annual savings. Therefore, to evaluate project formulation impacts, it was not necessary to consider alternatives larger in scope than the NED Plan. However, it was necessary to consider plan(s) of lesser scale. The average annual savings for the two alternatives described above are displayed in table 11 - 11. As the table shows, the reductions in average annual shallow-draft savings are five and seven percent, respectively, for the 900 x 90 x 22 ft and 900 x 110 x ft locks.

Comparison Summary

Table 11 - 11 provides a summary of the average annual shallow-draft savings by project alternative for each of the traffic growth scenarios.

DEEP-DRAFT

Low Growth Scenario

As described previously in Section 2, the low growth scenario for deep-draft traffic reflects no change in traffic activity from the baseline 1990 volumes. Therefore, the unconstrained total demand, lockages, and savings for all future years are identical to those described for the 1990 condition for each respective alternative.

High Growth Scenario

Projected deep-draft growth rates reflecting the high growth scenario have also been described earlier in Section 2. The resultant number of projected lockages and the associated savings from use of these high growth rates are detailed in tables 11 - 12 and 11 - 13, respectively.

No Growth after 20 Years

As was described earlier, the "No Growth After 20 Years" scenario reflects a condition where traffic is projected using the mid growth rates for only twenty years beyond the baseline traffic year. Given the 1990 baseline year, the terminal year of projections is 2010 for this alternative. Beyond 2010, traffic is held constant at the 2010 level. Because this scenario represents a truncated mid growth projection, demand, lockages, and savings are identical to the mid growth results for a specific year. However, the average annual savings for each project alternative differ from the mid growth scenario because traffic changes beyond 2010 are not considered. Average annual savings for the "No Growth After 20 Years" scenario are displayed in table 11 - 14.

Comparison Summary

Table 11 - 14 provides a summary of the average annual deep-draft savings by project alternative for each of the traffic growth scenarios.

For each of the 22-foot sill alternatives, the low growth scenario results in a smaller negative value, i.e., a smaller loss, than the mid growth scenario. This follows from the fact that the 22-foot sill alternatives provide a lesser level of deep-draft service than the existing lock. Therefore, with lower future demand, the low growth scenario results in a smaller loss for these alternatives compared to mid growth. This result does not hold for the 36-foot sill alternatives, however. For these alternatives, a lower level of demand produces a smaller savings compared to the mid growth since deep-draft service is enhanced with the 36-foot alternatives.

With the high growth scenario, the 22-foot sill alternatives produce a substantially greater loss than with the mid growth scenario. This occurs because of higher demand and the lower level of deep-draft service compared to the existing lock. For the 36-foot sill alternatives, the higher demand of the high growth scenario produces significantly higher savings than the mid growth scenario.

Table 11 - 12

High Growth Scenario
Total Deep Draft Lockages

Alternative		2000	2010	2020	2030	2040	2060
Existing	Intra	169.1	240.9	343.0	488.6	695.9	1,411.7
	Thru	20.6	29.4	41.8	59.6	84.9	172.2
	Total	189.7	270.3	384.8	548.2	780.8	1,583.9
900 x 90 x 22	Intra	136.5	194.5	277.0	394.5	561.9	1,139.9
	Thru	20.6	29.4	41.8	59.6	84.9	172.2
	Total	157.1	223.9	318.8	454.1	646.8	1,312.1
900 x 110 x 22	Intra	136.5	194.5	277.0	394.5	561.9	1,139.9
	Thru	20.6	29.4	41.8	59.6	84.9	172.2
	Total	157.1	223.9	318.8	454.1	646.8	1,312.1
900 x 110 x 36	Intra	224.1	319.2	454.6	647.4	922.2	1,870.8
	Thru	59.6	85.0	121.0	172.4	245.6	498.1
	Total	283.7	404.2	575.6	819.8	1,167.8	2,368.9
1200 x 90 x 22	Intra	136.5	194.5	277.0	394.5	561.9	1,139.9
	Thru	20.6	29.4	41.8	59.6	84.9	172.2
	Total	157.1	223.9	318.8	454.1	646.8	1,312.1
1200 x 110 x 22	Intra	136.5	194.5	277.0	394.5	561.9	1,139.9
	Thru	20.6	29.4	41.8	59.6	84.9	172.2
	Total	157.1	223.9	318.8	454.1	646.8	1,312.1
1200 x 110 x 36	Intra	224.1	319.2	454.6	647.4	922.2	1,870.8
	Thru	59.6	85.0	121.0	172.4	245.6	498.1
	Total	283.7	404.2	575.6	819.8	1,167.8	2,368.9

Table 11 - 13

Deep Draft Benefits
High Growth Scenario
(\$1,000's - 1993 Price Levels)

Alternative		1991	2000	2010	2020	2030	2040	2060
Existing	Intra	931	1,280	1,822	2,596	3,697	5,266	10,682
	Thru	11	15	21	30	42	60	122
	Total	942	1,295	1,843	2,626	3,739	5,326	10,804
900 x 90 x 22	Intra	669	920	1,311	1,867	2,659	3,787	7,683
	Thru	11	15	21	30	42	60	122
	Total	680	935	1,332	1,897	2,701	3,847	7,805
	Incremental	(262)	(360)	(511)	(729)	(1,038)	(1,479)	(2,999)
900 x 110 x 22	Intra	669	920	1,311	1,867	2,659	3,787	7,683
	Thru	11	15	21	30	42	60	122
	Total	680	935	1,332	1,897	2,701	3,847	7,805
	Incremental	(262)	(360)	(511)	(729)	(1,038)	(1,479)	(2,999)
900 x 110 x 36	Intra	1,413	1,942	2,766	3,940	5,611	7,992	16,213
	Thru	55	75	107	153	218	310	629
	Total	1,468	2,017	2,873	4,093	5,829	8,302	16,842
	Incremental	526	722	1,030	1,467	2,090	2,976	6,03
1200 x 90 x 22	Intra	669	920	1,311	1,867	2,659	3,787	7,683
	Thru	11	15	21	30	42	60	122
	Total	680	935	1,332	1,897	2,701	3,847	7,805
	Incremental	(262)	(360)	(511)	(729)	(1,038)	(1,479)	(2,999)
1200 x 110 x 22	Intra	669	920	1,311	1,867	2,659	3,787	7,683
	Thru	11	15	21	30	42	60	122
	Total	680	935	1,332	1,897	2,701	3,847	7,805
	Incremental	(262)	(360)	(511)	(729)	(1,038)	(1,479)	(2,999)
1200 x 110 x 36	Intra	1,413	1,942	2,766	3,940	5,611	7,992	16,213
	Thru	55	75	107	153	218	310	629
	Total	1,468	2,017	2,873	4,093	5,829	8,302	16,842
	Incremental	526	722	1,030	1,467	2,090	2,976	6,038

Table 11 - 14

Comparison of Deep-Draft Incremental Benefits
(1996, \$1,000, 7.375%)

Alternative	Average Annual Benefits				Percent Advantage vs Mid Growth			
	Mid	Low	High	No Growth After 20 Yrs	Mid	Low	High	No Growth After 20 Yrs
900 x 90 x 22	(477)	(268)	(892)	(375)	0	45	(82)	23
900 x 110 x 22	(477)	(268)	(892)	(375)	0	45	(82)	23
900 x 110 x 36	979	539	1,862	757	0	(45)	91	(22)
1200 x 90 x 22	(486)	(268)	(925)	(375)	0	45	(91)	23
1200 x 110 x 22	(486)	(268)	(925)	(375)	0	45	(91)	23
1200 x 110 x 36	979	539	1,862	757	0	(45)	91	(22)

Compared to the mid growth scenario, the "No Growth After 20 Years" scenario, produces smaller losses for the 22-foot sill alternatives and smaller savings for the 36-foot sill alternatives. As before, the amount of savings compared to the mid growth scenario depends on the relative magnitudes of demand and deep-draft service provided.

PROJECT FORMULATION

To explore the implications of alternative traffic growth rate assumptions on project formulation, the average annual net benefits for each alternative plan were determined using the low and high growth scenarios previously described. The results of these low and high growth scenarios are displayed in table 11 - 15 and table 11 - 16, respectively. Table 11 - 17 provides the same information for the "No Growth After 20 Years" scenario.

Comparing the results of the alternative growth scenarios with the results of the mid growth scenario reveals that the NED plan is sensitive to traffic growth projections. As is shown in table 11 - 15, with the low growth scenario, the NED plan nearly shifts to the next smallest scale alternative, the 900 x 90 x 22 ft lock. The high growth scenario in table 11 - 16 reveals no change in the NED plan (900 x 110 x 22 ft lock) as compared to the mid growth projections. There are higher annual benefits associated with the larger alternative lock sizes when high growth is assumed, but not by enough to change the NED plan. Table 11 - 17 reveals that the "No Growth After 20 Years" scenario results in a 900 x 90 x 22 ft lock NED plan.

Tables 11 - 15 through 11 - 17 also reveal that despite the variation in savings associated with the different growth scenarios, all the with-project plans would be economically justified in the low and high growth scenarios. In the "No Growth After 20 Years" scenario, only the bridge curfew removal alternative would be economically unjustified.

TIMING

PHASED CONSTRUCTION

Reviewing table 7 - 4, which displays projected average delay per tow estimates for the alternative plans, reveals that if the existing low-rise St. Claude Avenue Bridge is replaced with a mid-rise structure, while keeping the existing lock in place, short term reductions in average delays per tow compared to the without-project condition would result. This in turn would produce short term